Acurex Final Report FR-85-156/ESD

# ENERGY ENGINEERING ANALYSIS PROGRAM

## Fort Ord/Presidio of Monterey

March 1988



Acurex Project 6033
Contract No. DACA05-80-C-0008

For

Department of the Army
U.S. Army Engineer District
Corps of Engineers
650 Capital Mall
Sacramento, California 95814



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## EXECUTIVE SUMMARY

This volume contains the findings and low-cost/no-cost recommendations of energy use investigation of Increment F buildings. Energy use surveys were conducted for approximately 100 buildings. From the energy use survey, 12 low-cost/no-cost energy conservation opportunity (ECO) projects were developed as shown in Table 1.

Detailed economic analyses were completed for each project. Based on these analyses, all 12 projects are recommended. These projects cover the areas of reducing heating-energy consumption, reducing electrical consumption, and reducing natural-gas consumption. Total energy saved from these projects is 26,670 million Btu/year. Total construction costs for these projects is $117,400.

During the 5 years from 1984 to 1989, Fort Ord and the Presidio of Monterey will add 2,607,178 ft$^2$ of building space. With a projected energy use of 125,500 Btu/ft$^2$/year in 1990, the additional space will add 327.2 billion Btu/year to the installations energy use. Enactment of the projects outlined in this report will save approximately 133,350 million Btu over the next 5 years. These estimates are based on the assumption that all audited buildings will be in use past 1990.

## 1. OBJECTIVES AND APPROACH OF INCREMENT F

The overall objectives of this analysis are to continue the work performed under Increments A and B by recommending low-cost/no-cost modifications to buildings, systems, or system operations for energy conservation in the Increment F buildings at Fort Ord and the Presidio of Monterey (POM). Energy consumption on a square-foot basis at these facilities has increased substantially above the target levels (Figures 1 and 2), lending further urgency to this project. The energy savings recommendations are presented as specific, practical instructions for use by the Director of Engineering and Housing (DEH) and are within his funding authorization ($200,000 for alterations and $1,000,000 for maintenance or repair type of work) and management control. An additional objective of this project is to integraté the analysis with past energy conservation work by providing a comprehensive document of all energy conservation modifications accomplished to date by Fort Ord and the Presidio of Monterey (POM).

These objectives were fulfilled by conducting a site survey of the buildings identified by the Increment F statement of work. These buildings are listed in Annex A to this report. Experienced engineers noted the major characteristics of each building, identified the energy consuming systems in each building, such as space heating, domestic or process hot water, and auxiliary systems (e.g., the compressed air supply used in the dental clinics), and noted the condition and operating practices of each of these systems. They then defined the potential low-cost/no-cost energy conservation opportunities (ECOs) for each building and ranked them based on economic analyses.

The results are presented in tabular form with brief narrative description to indicate the reason for modification. Included are the

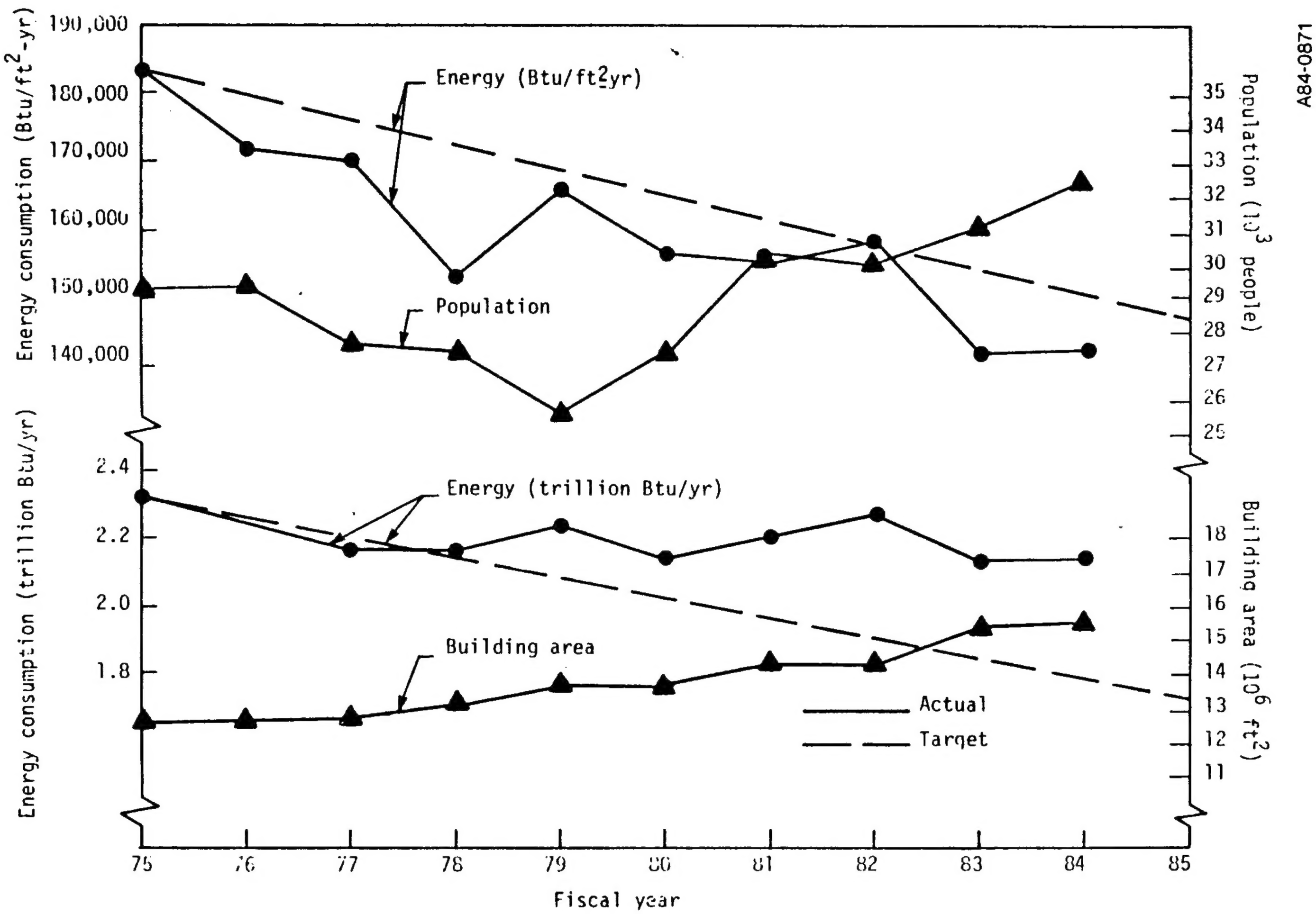


Figure 1. Annual Energy Consumption -- Fort Ord

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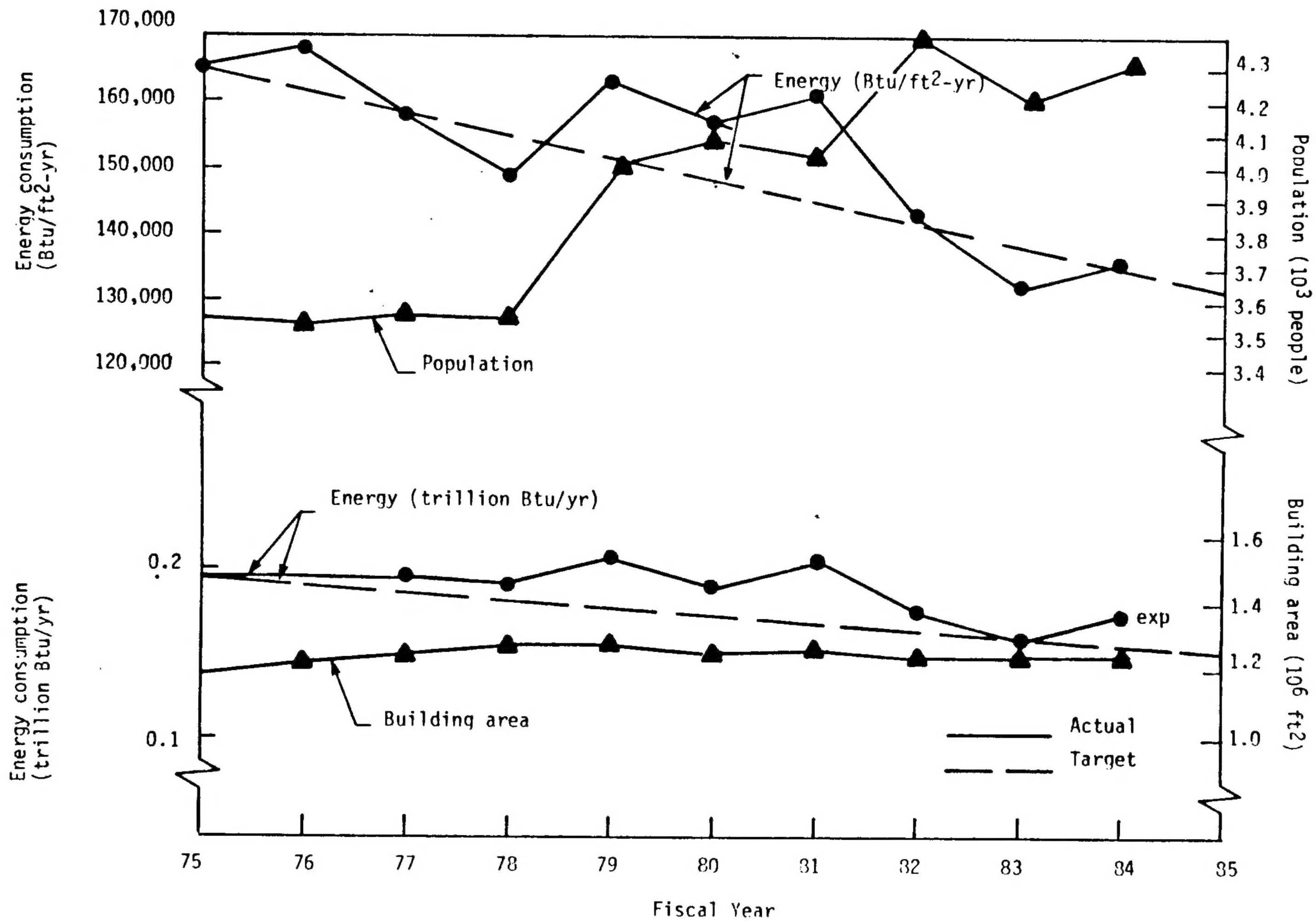


Figure 2. Annual Energy Consumption -- POM

implementation costs, energy savings, and Savings/Investment Ratios (SIR). SIRs are computed according to the "Energy Conservation Investment Program (ECIP) Guidance" document (dated 10 August 1982 and revised 18 January 1983). In addition, supporting data are provided for any projects that could be funded under (1) the Quick Return on Investment Program (QRIP), (2) the OSD Productivity Investment Funding (OSD PIF), or (3) the Productivity Enhancing Capital Investment Program (PECIP).

This submittal describes the survey methodology (Section 2), the general characteristics of the buildings (Section 3), space heating systems (Section 4), and domestic hot water heaters or boilers (Section 5). It then presents in Section 6 and Annex B the potential low-cost/no-cost ECOs for each building surveyed. The summary and recommendations for each low-cost/no-cost ECO are presented in Section 7. A review of these individual ECOs shows that they can be grouped into 12 projects. Each of these projects, which meet the low-cost/no-cost criteria is presented in a summary table with cost and energy implications for application to a single building. Estimates of the total costs and potential annual energy savings that could be recognized by implementing each project on all applicable buildings at Fort Ord and POM are presented in the same summary (see Table 1).

Economic analyses of all the ECOs according to the ECIP guidance document are provided in Appendix I. This methodology is applied to the projects, and the results are presented in this report. This report also includes a listing with dates of all energy conservation modifications accomplished by Fort Ord and POM since 1975 (see Annex J), and a summary of the potential savings from Increment F and the master plan changes (see Executive Summary).

## 2. SURVEY METHODOLOGY

The survey methodology was defined after discussions with Fort Ord DEH personnel and the Corps of Engineers. The first step in the process was to define the worksheet which was to be completed during the survey. A worksheet form was completed and reviewed by DEH personnel. Samples of the completed sections of the worksheets for the buildings surveyed are shown in Annexes E, F, G, and H. The worksheet contained space for information on building number, use, population, and hours of use. Then, information was asked for in five major areas:

- Heating and air conditioning
- Hot water systems
- Interior lighting
- Exterior lighting
- Other equipment (kitchen, refrigerators, etc.)

Under heating and air conditioning systems, a short equipment description was completed. The main heat losses for the building were identified and broken into two types: infiltration and high heat transfer. Infiltration applied to windows and doors, and high heat transfer applied to wall and ceiling insulation, thermostats and time program systems, lines and ducts, and leaks.

The next information requested was specific to the heating and air conditioning systems. This information included type of system (electric, oil, or natural gas) as well as size.

Once the heating and air conditioning systems were described, any potential energy savings were noted and drawings for heat load calculations were completed. Then the building was described, construction materials and type (single or double wall) were identified.

Information on the building's hot water system was required next. The type of hot water system was identified, and the approximate gallons per day usage. The capacity, efficiency, and temperature setting were determined and any potential energy savings were noted.

In the next two sections of the worksheet, the interior and exterior lighting were described. In these sections, the type and size of lighting was requested. Also, the task area description (parking lot, classroom, library, etc.) was requested.

The last section of the worksheet primarily functioned as a means of describing energy uses which did not fit into the other categories. A description of the energy user and size of the use was requested. Space was provided to note any potential energy savings.

During the survey, a worksheet was completed for each building. To complete the survey, each building was examined by an energy engineer, with special attention paid to low-cost/no-cost opportunities. During the examination, the engineer assessed the building heating system for appropriate operation (correct temperatures, fan operation, etc.). If the building was above authorized temperature, and the heating system was operating, notes were made on the audit sheets. Also, the adequacy and efficiency of the heating system was assessed. If heating system pipes were uninsulated, it was noted on the audit sheets.

Most buildings surveyed were not authorized for hot water, and therefore, the hot water system was not in service. If the hot water system was in service, the adequacy and efficiency of the system was noted on the audit sheets. Also, in some cases, the buildings had recirculating hot water systems with the recirculating pumps working full time. These ocurrences were noted on the audit sheets.

Acurex had recently completed a survey of the interior and exterior lighting systems on Fort Ord (see Increments A, B, and G), therefore the surveyors did not attempt to measure lighting levels in each building, but examined the type of lighting available and whether it use was appropriate for the task. Inappropriate lighting uses were noted on the audit sheets.

Most buildings surveyed did not have equipment which fit into the "other" category. However, there were some buildings with refrigerators, coffee makers, stereos, televisions, etc. No attempt was made to chronicle all equipment which fit into this category, however, instances of inappropriate use were noted on the audit sheets.

Once the audits were completed, possible low-cost/no-cost ECO lists were completed for each surveyed building (see Annex B). This list was examined to determine possible low-cost/no-cost ECOs which fit low-cost/no-cost requirements. The following sections of the report detail the findings of the surveys and provide the results of the economic analyses of the low-cost/no-cost ECOs.

## 3. BUILDINGS

The characteristics of buildings that most affect their suitability for ECOs are their age and construction. New buildings have a relatively long remaining life and, therefore, can benefit from low-cost/no-cost ECOs that are amortized over several years. In addition, the new buildings at Fort Ord and POM generally have low heat losses, which can be reduced even further by low-cost improvements. Older buildings, on the other hand, can have short remaining lives, experience high heat losses, and be expensive to insulate.

Specifically, the buildings at Fort Ord and POM can be classified by construction type into three groups:

- Buildings with concrete or concrete block walls and ceiling insulation
- Buildings with concrete walls and no ceiling insulation
- Buildings with single or double plywood walls and no insulation on the ceiling (or walls)

The first group consists of the new, well insulated buildings with low heat loss through the structure. The second group of buildings are also relatively new and need only the addition of ceiling insulation to decrease heat loss significantly. These buildings are expected to last more than 20 years and should be insulated as soon as possible to take full advantage of this potential energy and cost savings. Their quality and projected lifetime virtually ensures their continued utilization; hence, there is little risk in implementing this recommendation expeditiously.

The third group of buildings are old with very high heat losses. Insulation of the walls in single-wall buildings requires adding an internal wall which substantially increases the insulation costs. Double-wall buildings are also difficult to insulate due to lack of easy access to the spaces between each pair of studs and the interference to blowing insulation into this dead space by the horizontal or diagonal structural reinforcement members.

Lighting in buildings was observed during the surveys. In general, lighting in office buildings and barracks was kept to an acceptable minimum. Natural lighting was used in offices and barracks where windows were available. In the office buildings where lighting was in use, it was usually fluorescent. Desk or table lamps were in use in many offices. These lamps were usually fluorescent, but there were some incandescent lamps in use. Some

energy savings could be realized by converting or replacing the incandescent lamps.

In hangars, machine shops, and warehouses, lighting was mostly fluorescent, with some incandescent. The lighting systems were not using energy-efficient bulbs. These lighting systems could be made more energy efficient by replacing the incandescent lighting with fluorescent. Mercury or Sodium vapor lighting could be used for large open spaces.

Most of the buildings audited contained no electric motors except for small 1/4- to 1/2-hp motors for the recirculating pumps. Other electrical equipment in the buildings included forced air fan motors and lighting. In offices, table lamps, coffee pots, hot plates, and small refrigerators were also noted. No attempt was made to categorize this equipment during the audits due to the small size of the motors and the small loads of the other equipment.

## 4. HEATING SYSTEMS AND BOILERS

### 4.1 Heating Systems

The buildings at Fort Ord and POM are equipped with a diversity of heating systems. The most common is circulating hot water with radiators or convectors in each room of the building. In some buildings, however, the hot water feeds coils situated in the ducts of a forced-air heating system. In either configuration, most of the systems also have three-way valves that control the flow of hot water into the radiator, convector, or coil (i.e., control the split of flow between the heater elements and the bypass).

A small number of buildings have both low-pressure steam heating systems and forced-air units. The steam systems have either cast iron radiators or steam coils, while the forced-air units can be individual or central. A few buildings are equipped with forced-air heating systems that

use either gas-fired heat exchangers in the duct or combinations of heating and cooling coils.

All the wooden buildings have forced-air heating using a gas-fired furnace or gas-fired space heaters. Some of the other buildings and machine shops are also heated by this type of system.

## 4.2 Boilers and Furnaces

The hot water boilers are either firetube or cast iron units. The firetube boilers have integrated burners with the fan and pump incorporated. As the design of these burners allows adjustment of the excess air, the efficiency of the boiler can be improved. Many of the cast iron boilers however, are equipped with inspirator gas burners (gas inspirates the air through a venturi). Since it is physically impossible to adjust excess air in these burners, they cannot be tuned to minimum excess air to increase thermal efficiency.

The steam boilers are low-pressure (10 psi) units fired by either inspiration or integrated burners. Only three or four boilers have chemical water treatment. Although approximately 95 percent of the condensate is returned to the boiler, the systems still need additional makeup water because of loss of condensate due to evaporation from the tank and leakage. The use of untreated makeup water creates problems due to scaling and the formation of deposits on the heating surfaces.

The furnaces in most of the buildings surveyed were approximately 20 years old. Typical efficiencies for units of that vintage were 65 to 70 percent at best. Due to the furnaces' age, the efficiencies are less than that due to corrosion and scaling of the high temperature heat exchange surfaces.

## 5. DOMESTIC HOT WATER SYSTEMS

In most buildings domestic hot water is produced by gas-fired water heaters. A limited number of electric hot water heaters and storage tanks with heat exchangers also exist. More than 50 percent of the systems have recirculating hot water pumps with double lines, and all these pumps run continuously, 24 hours a day.

The water on the inlet of the water heaters is not treated for hardness or to prevent deposits (scaling). Scaling and deposit buildup occurs on the heat exchanging surfaces of every hydronic and steam heating system. These deposits cause an increase in the temperature of the exhaust gases (up to 220° to 240°F) and consequent reduction in the heater's efficiency.

Also, the thermostat on most heaters was found to be set at 160° to 170°F, which is too high. Maintaining and delivering hot water at these temperatures results in unnecessarily high heat losses, especially from the uninsulated supply lines.

Several techniques of improving the efficiency of the hot water systems were investigated. These included:

- Replacement of existing units with high-efficiency units
- Preventing scaling and formation of deposits
- Operating the hot water circulating pump only during working hours

Replacement of the existing hot water heaters with high-efficiency units would yield little, if any, advantage. High-efficiency units have high initial costs as compared to the current models used. Also, with current water quality requiring the replacement of the water heater every 2 to 3 years, recouping the higher initial cost through energy savings would not occur. The possibility of higher insulation value for the high efficiency hot

water heater was also investigated. The manufacturers we talked with indicated all their water heaters were insulated to the same R value.

We also investigated switching to spark ignited hot water heaters when replacing the existing heaters. We could not find a manufacturer who produced a spark ignited water heater of less than 200,000 Btu/hr capacity, which is much larger than most of the heaters observed.

Local prevention of scale formation was also investigated. Conventional means of ion exchange or other softening agents were deemed too labor intensive for local softening. Water treatment at a central facility would solve many water quality related problems without the labor intense nature of local treatment.

Before implementing any ECO, the thermostats on the existing systems should be reset based on the use of the hot water:

- Restrooms only (e.g., in office buildings) 100°F
- Living quarters (e.g., with showers) 110°F
- Kitchens and dining facilities 140°F

# 6. INCREMENT F PROJECT SUMMARY

## 6.1 Energy Conservation Opportunities -- Low-Cost/No-Cost

A list of each ECO investigated, with economic and energy savings summary information, is presented in Table 1. The buildings to which each apply are presented in Table 2. In Annex B, a list of low-cost/no-cost ECOs for each building surveyed is presented. Not all ECOs presented in Annex B were analyzed. Some were considered too costly to implement. Others are not easily applicable. The various low-cost/no-cost ECOs which were analyzed are discussed below.

Table 1. Low-Cost/No-Cost ECO Summary

| ECO | Number of Buildings | Cost for One Building (dollars) | Energy Savings Per Building (mBtu/yr) | Total Cost ($K) | Total Energy Saving ($K/yr) | Payback Period (years) | SIR |
|---|---|---|---|---|---|---|---|
| 1. Insulate piping in gymnasium -- Building 2248 | 1 | 6,925 | 4,710 | 6.9 | 24.9 | 0.28 | 70.3 |
| 2. Insulate piping | 14 | 585 | 218.6 | 8.19 | 16.22 | 0.50 | 38.6 |
| 3. Thermostatic valves | 31 | 558 | 148.5 | 17.3 | 24.4 | 0.71 | 27.5 |
| 4. Timers for air compressors and vacuum pumps | 5 | 1,955 | 796.5 | 9.78 | 29.87 | 0.33 | 22.7 |
| 5. Photosensors for outside lighting | 4 | 127 | 50.8 | 0.51 | 1.52 | 0.34 | 22.2 |
| 6. Boiler tuneups | 38 | 93.5 | 184 | 3.55 | 37.05 | 0.10 | 9.70 |
| 7. Timer for circulating hot water pump | 15 | 400 | 73.3 | 6.0 | 6.09 | 0.98 | 8.57 |
| 8. Insulate ceilings | 28 | 1,581 | 59.8 | 44.27 | 8.87 | 5.0 | 3.9 |
| 9. IR heaters | 1 | 7.57 | 140 | 7.57 | 0.74 | 10.2 | 1.91 |
| 10. Replace 200,000 Btu/hr furnace with two 100,000 Btu/hr high-efficiency furnaces | 3 | 2,241 | 41.0 | 6.72 | 0.66 | 10.2 | 1.89 |
| 11. Replace 80,000 Btu/hr furnace with high-efficiency furnace | 1 | 1,028 | 16.4 | 1.03 | 0.087 | 11.8 | 1.65 |
| 12. Replace 150,000 Btu/hr furnace with high-efficiency 80,000 and 60,000 Btu/hr furnace | 2 | 2,792 | 31.0 | 5.58 | 0.33 | 16.9 | 1.15 |

Table 2. Buildings to Which Each Low-Cost/No-Cost ECO Applies

| | | |
|---|---|---|
| 1. | Insulate piping in gymnasium | 2248 |
| 2. | Insulate piping | 2917, 2995, 236, 1002, 268, 4390, 2521, 2544, 2550, 2582, 2562, 2795, 622 |
| 3. | Replaced radiator valves with thermostatic valves | 527, 533, 535, 1136, 2060-2061, 2661, 2798, 3005, 3593, 3701, 4250, 4451, 4483, 4570, 4575, 4883, 4899, 1002, 4360, 4386, 4430, 4562, 4580, 4791, 4792, 4793, 622, 620, 627, 268 |
| 4. | Timers for air compressors and vacuum pumps | 3700, 3599, 422, 4390, 3585 |
| 5. | Photosensors for outside lighting | 1136, 4280, 4426, 3701 |
| 6. | Boiler tuneups | 507, 521, 527, 533, 1136, 2060, 2061, 2237, 3585, 3595, 3599, 3700, 3701, 3702, 4230, 4260, 4280, 4426, 4451, 4455, 4575, 4885, 4899, 4953, 614, 622, 623, 624, 3005, 3007, 3630, 4386, 4430, 4562, 4580, 208, 627, 620 |
| 7. | Timer for circulating hot water pump | 507, 510, 527, 533, 2798, 2995, 3703, 4230, 4235, 4280, 4426, 4573, 614, 4885, 2237 |
| 8. | Insulate ceilings | 507, 510, 527, 533, 535, 1449, 2521, 2544, 2550, 2582, 2562, 2661, 2726, 2786, 2795, 2798, 2821, 2861, 2901, 2917, 3005, 4251, 517, 1002, 1009, 3007, 3630 |
| 9. | Replace space heaters with IR heaters | 2426 |
| 10. | Install two 100,000 Btu/hr high-efficiency furnaces | 1009, 4251, 4408 |
| 11. | Install high-efficiency furnace | 110 |
| 12. | Install 80,000 and 60,000 Btu/hr high-efficiency furnaces | 4560, 4585 |

6.1.1 Insulate Piping in Gymnasium -- Building 2248

Building 2248 is a large gymnasium with a steam boiler and convector heating. The approved heating temperature for this building is 55°F. On the day of the audit, internal temperature of the building was 85°F with an ambient temperature of 68°F. The steam boiler was operating and steam flowing through two 4-inch uninsulated pipes inside the gym.

Since steam boilers are difficult to start up, the boiler cannot be shutdown during short periods when it is not in use (i.e., overnight). Replacement of the steam boiler (which is relatively new) with a hot water boiler would be quite expensive.

Currently heat loss through the 4-inch pipe is substantial. Insulation of the pipes would reduce this heat loss.

6.1.2 Insulate Piping

Insulation of the hot water or steam piping in buildings where the piping is accessible could cut energy use in those buildings. In many buildings, the hot water piping is inaccessible (i.e., in walls), however, in several buildings the piping was suspended from overhead pipe hangars and is easily accessible. These buildings should have this piping insulated both for an energy saving and a comfort standpoint. In the buildings (like Building 1002) where the hot water pipe was exposed in hallways, the temperature in the hallway was quite uncomfortable.

6.1.3 Thermostatic Valve Replacement

Replacement of radiator valves with thermostatic valves would reduce steam and hot water usage. In some buildings with radiators, the rooms near the beginning of the steam line were quite warm whereas those at the end of the line were quite cool. Thermostatic valves would more successfully regulate the room temperature, and reduce the room to room temperature

variation. Another benefit of thermostatic valves, is that they can be factory set for a maximum approved temperature. In other words, since the maximum approved temperature for most buildings on Fort Ord is 65°F, the thermostatic valve could be factory set for a maximum allowable temperature of 65°F, and temperature could only be regulated below 65°F.

6.1.4 Timers for Air Compressors and Vacuum Pumps

The air compressors and vacuum pumps in the dental clinics operate 24 hours a day, 7 days a week. Considerable energy could be saved by installing timers that shutoff the equipment during nonworking hours.

6.1.5 Photosensors for Outside Lighting

The outside security lights on the buildings should be equipped with photosensors to turn these lights on only when needed. In most cases these lights now operate during all nonworking hours, including the daylight hours before/after working time and over the weekend when the building is not used.

6.1.6 Boiler Tuneup

Many of the buildings are equipped with boilers to supply hot water or steam for the heating systems. Those boilers that are fired by individual burners can be tuned to minimize the excess air in the exhaust. This adjustment can be performed on burners with either integral or separate fans. Precise adjustment of the burners can reduce the excess air 25 to 30 percent while still meeting regulations for CO and soot content (Bacharach number) in the exhaust gases. Most of the boilers that were observed had blue flames, indicating operation at high excess air.

Reducing the excess air by 25 to 30 percent can produce annual fuel savings of approximately 2.0 percent for gas-burning boilers and 2.5 percent for oil-burning boilers. Boilers with inspiration gas burners cannot be tuned because of their burner design.

Boiler tuning on small boilers is a low-cost and low-investment project. The only investment cost is for one portable, rapid-response exhaust gas analyzer for the entire installation. Labor costs are nominally $100 per boiler per year.

### 6.1.7 Timer for Circulating Hot Water Pump

As stated in Section 4, the hot water circulating pumps in many of the buildings operate 24 hours a day. In many cases, shutting the pump down during periods (overnight) when hot water would not be used would save substantial energy. Shutting down the pump could be accomplished by adding a timer to the circuit.

### 6.1.8 Insulate Ceilings in Buildings

All the wooden buildings have uninsulated walls and ceilings. Insulation of the walls would be an expensive addition on those buildings with double or single walls. In both cases the walls would have to be insulated and a new wall constructed over the insulation. However, ceiling insulation is much easier to install and reaps greater energy savings.

Initial discussions with Fort Ord personnel indicated that all World War II (WWII) vintage buildings would be demolished before 1990. Current indication shows, however, that all audited buildings will be in use past the year 1990. Simple payback on ceiling insulation is approximately 5 years, therefore, all buildings noted in Table 2 should have the ceilings insulated since their useful life is greater than 5 years.

### 6.1.9 Infrared Heaters

In large open buildings with isolated work areas, infrared space heating of the work areas would reduce the gas heating load on the installation. The infrared heaters would be placed only over those areas where work was taking place. With infrared heat, energy is not lost heating

air that can move to a cold part of the building and lose heat, nor is electrical energy used to circulate warm air. With direct infrared heating of the works area, heat loss is minimized and heat load is reduced.

6.1.10 High-Efficiency Furnaces

There are three projects to replace existing forced air furnaces with high-efficiency furnaces. According to the manufacturer's literature and other reports, the most efficient furnace available today is the Lennox Pulse Furnace at 97 percent efficiency. This furnace is available up to 100,000 Btu/hr capacity.

Buildings with projected lives of greater than approximately 15 years, and whose heating needs can be met by a high-efficiency furnace should have these furnaces installed. On buildings with greater than 100,000 Btu/hr heating requirement, 2 units can be installed with little difficulty using the existing installation. For example, a 150,000 Btu/hr furnace in a 2-story building could be replaced by an 80,000 Btu/hr furnace for the bottom floor and a 60,000 Btu/hr furnace for the top floor. Similar arrangements could be used to produce up to 200,000 Btu/hr output.

Fort Ord is currently experimenting with a pulse-combustion furnace. However, no results have been presented on fuel savings realized from use of this type of furnace at the installation. An appropriate test for this type of unit would be to select two similar buildings with similar heating loads and retrofit one with a pulse-combustion furnace. Fuel usage and maintenance for the two buildings should be recorded.

7. PROJECT ECONOMIC ANALYSIS AND RECOMMENDATIONS

A summary of the economic analyses of each low-cost/no-cost ECO and the recommended projects are presented in this section.

## 7.1 Analysis Methodology

The 12 low-cost/no-cost ECOs are summarized in Table 1 with cost and energy savings estimates. These estimates are provided for both a single installation (i.e., to one building) and uniform implementation on all relevant buildings at Fort Ord and POM. The unit cost data were obtained by telephone conversations with equipment suppliers or from their catalogs, and estimates of installation labor were taken from "Means Mechanical Estimating, 1985." The energy saving projections were developed from (1) known or estimated system efficiencies of existing equipment and/or operation modes, and (2) specified performance for new equipment or calculations of energy not consumed by avoiding nonproductive operations. These calculations and assumptions are presented in Annex I. The Life Cycle Cost Analysis Summary, manhour estimate, manhour cost, and equipment cost and assumptions for each project calculation are also presented in Annex I. These analyses follow the approach in the "ECIP Guidance" document (revised January 18, 1983).

## 7.2 Summary and Recommendations

Twelve possible low-cost/no-cost ECOs are presented in Table 1. These low-cost/no-cost ECOs can be broken into five main areas:

- Insulation
- Temperature control
- Timing control
- Boiler tuneups
- High-efficiency heating

Fort Ord and POM in general are minimally insulated. The new buildings are well-insulated and are energy efficient. However, the old buildings are noninsulated. Installation of wall insulation in these buildings would be very expensive. Ceiling insulation, however, is relatively inexpensive and

has a reasonable payback period (5 years). Based on our conversations with Fort Ord DEH personnel, all buildings audited are likely to still be in use past 1990, approximately 5 years from now, and, therefore, all applicable buildings should be insulated.

Temperature control of offices and barracks will result in energy savings. Some of the buildings had timer and temperature control for the heating furnace to control energy use. Thermostatic valve control of the radiators in the buildings without temperature control will aid in energy savings. The thermostatic valves will control the flow of heating fluid through the radiator to maintain a set temperature. Fort Ord and the POM have maximum allowable indoor heating temperatures (usually 65°F), therefore, the thermostatic valves should be factory set to prevent heating above that maximum allowable heating temperature.

Examination of the low-cost/no-cost ECOs analyzed leads to the recommendation of enacting all the projects. The projects which deal with temporary buildings have payback periods of 5 years or less. As stated earlier, all audited buildings have a life expectancy of greater than 5 years. Of the three projects of payback periods greater than 5 years, only one temporary building is included (1009). Proceeding with the installation of a high-efficiency furnace in this building would have to be evaluated on an individual basis. All other buildings with greater than 5 years life are considered permanent buildings and should be in use well into the next century.

Before proceeding with projects 10, 11, and 12, Acurex recommends that the savings of high-efficiency furnaces be documented at the installation. A program to document the savings would involve selecting two similar buildings with similar heating loads. Install a high-efficiency furnace with a gas

meter in one building and a regular furnace with a gas meter in the other, then monitor the gas usage for each building for a period of 1 year. The savings could then be readily documented.

Of the total projects recommended, only the boiler tuneup low-cost/no-cost ECO requires personnel training. There is no government-sponsored program in boiler tuneup or optimization. However, many agencies such as the American Energy Engineers and the California Energy Commissions teach classes in the Bay Area. These classes are 2 to 3 days long and cost \$350 to \$550. The California Energy Commission also sponsors classes in energy audit training.

Timing control of compressors, pumps, and outside lighting are areas of possible energy savings. Most of the boilers observed during the audit showed blue flames (i.e., high excess air). Reduction of the excess air through exhaust gases and boiler tuneup analysis could reduce energy consumption. Replacing existing forced air furnaces with high efficiency units where applicable would also save energy.

Equipment will need to be purchased to complete the ECOs. The items and their sources are shown below:

| | Item | Source |
|---|---|---|
| 1. | Pipe insulation (2-inch fiberglass) | Metalclad, Owens-Corning |
| 2. | Ceiling insulation (6-inch, R-19) | Owens-Corning |
| 3. | $O_2$ analyzer | VWR catalog/FYRITE catalog #32034-002 |
| 4. | High efficiency forced air furnace | Lennox Pulse Combustion Furnace |
| 5. | Timers (7 day) relays-interposing | Tork, Eagle, Westinghouse, Allen-Bradley |
| 6. | Photosensors (2,000 watt) | Dayton, General Electric |

7. Thermostatic valves — Danfoss, Honeywell

8. IR heater — McMaster-Carr

The $O_2$ analyzer will require a refill kit approximately one time each year. This kit is also available from VWR.

## 7.3 Project Funding

A summary of the funding categories and the requirements of each is presented below:

1. Quick Return on Investment Program (QRIP) -- this program is for projects which have a total cost which does not exceed $100,000 and will amortize in 2 years or less

2. OSD Productivity Investment Funding (OSD PIF) -- this program is for projects which have a total cost greater than $100,000 and will amortize in 4 years or less

3. Productivity Enhancing Capital Investment Program (PECIP) -- this program is for projects which have a total cost of more than $3,000 and will amortize in 4 years or less

4. Energy Conservation Investment Program (ECIP) -- this program is for projects which have a total cost of more than $200,000

5. Local -- $1,000,000 maximum for repair work
   -- $200,000 maximum for new work

Table 3 presents a possible funding source for each low-cost/no-cost ECO.

## 7.4 Low-Cost/No-Cost ECO Summaries

Each of the low-cost/no-cost ECOs is summarized in the following paragraphs. These summaries are derived from detailed information presented in Annex I.

Table 3. Possible ECO Funding Source

| ECO | Possible Funding Source |
|---|---|
| 1. Insulate piping in gymnasium -- Building 2248 | PECIP |
| 2. Insulate piping | PECIP |
| 3. Thermostatic valve replacement | PECIP |
| 4. Timers for air compressors and vacuum pumps | PECIP |
| 5. Photosensors for outside lighting | Local |
| 6. Boiler tuneups | PECIP |
| 7. Timer for circulating hot water pump | PECIP |
| 8. Insulate ceilings | PECIP |
| 9. IR heaters | Local |
| 10. Replace 200,000 Btu/hour furnace with two 100,000 Btu/hour high-efficiency furnaces | Local |
| 11. Replace 80,000 Btu/hour furnace with high-efficiency furnace | Local |
| 12. Replace 150,000 Btu/hour furnace with high-efficiency 80,000 and 60,000 Btu/hour furnace | Local |

## Insulate Pipes in Gymnasium

Building 2248 is a gymnasium used for a variety of activities including basketball, boxing and weightlifting. The building is served by a steam boiler primarily to provide heating. Our site survey revealed that steam was passing through the lines even though the internal temperature of the building was 30° above the approved heated temperature of the building (55°F). The boiler cannot be shutdown because of the need to supply saunas in the gym. The sauna steam load could be met by purchasing and installing small steam boilers specifically for the saunas, therefore allowing the larger boiler to be shutdown. However, the capital requirements to accomplish this are greater than can be accomplished within low-cost/no-cost guidelines.

Energy savings could be realized by insulating the steam lines running inside the gym. The steam line in the gym is 4 inches in diameter. Two inches of fiberglass insulation on this line would effectively cut heat loss.

| Economic analyses | |
|---|---|
| Annual energy savings (MBtu) | 4,710 |
| Annual energy savings ($) | 24,963 |
| Construction cost[a] | 6,900 |
| Savings-to-investment ratio | 70.3 |
| Simple payback period (years) | 0.28 |

[a]Construction cost breakdown:

| | |
|---|---|
| Materials | 4,440 |
| Labor | 2,460 |
| Manhours (mechanical) | 123 |

## Insulate Piping

There are a number of buildings in Fort Ord and the POM which have uninsulated hot water or steam pipes. These buildings also have continuously

circulating hot water or steam. The heat loss from this piping is substantial. The typical building used for the life cycle cost analysis is a two-story wooden frame barrack.

| Economic analyses (per building) | |
|---|---|
| Annual energy savings (MBtu) | 218.6 |
| Annual energy savings ($) | 1,158 |
| Construction cost[a] | 583 |
| Savings-to-investment ratio | 38.6 |
| Simple payback period (years) | 0.50 |

[a]Construction cost breakdown:

| | |
|---|---|
| Materials | 382 |
| Labor | 201 |
| Manhours (mechanical) | 10.1 |

Energy savings could be realized by insulating this exposed piping. Most of the piping observed was 1-1/2-inch piping. Two inches of insulation on this piping would effectively cut heat loss.

Thermostatic Valve Replacement

In most Fort Ord and POM buildings with steam or hot water heating, the radiators are not thermostatically controlled, but have simple manual flow control valves. With this system the radiators at the beginning of the line are much hotter than those at the end of the line. Hence, the offices at the beginning of the line are overheated and those at the end of the line are underheated,

Replacement of the flow control valves with thermostatic valves will allow even heating of the offices or barracks. Also, the thermostatic valves can be factory set to the maximum allowable heated temperature (65°F). For this economic analysis, it was assumed that a building of approximately

3,600 $ft^2$ would require 10 thermostatic valves. This would be typical for a two-story wooden frame office building.

| Economic analyses (per building) | |
|---|---|
| Annual energy savings (MBtu) | 201.6 |
| Annual energy savings ($) | 1,068 |
| Construction cost[a] | 555 |
| Savings-to-investment ratio | 37.4 |
| Simple payback (years) | 0.52 |

[a]Construction cost breakdown:

| | |
|---|---|
| Material | 155 |
| Labor | 400 |
| Manhours | 20 |

Timers for Compressors and Vacuum Pumps

Air compressors and vacuum pumps are used in buildings such as dental clinics. In these buildings, the compressors and vacuum pumps are running 24 hours a day even though the clinic is only in use from 8 am to 5 pm. Switches were not provided when the building was built to allow safe disconnection of the machinery.

Timers which would shut the machinery off during non-use hours would save substantial electrical energy.

| Economic analyses (per building) | |
|---|---|
| Annual energy savings (MBtu) | 796.5 |
| Annual energy savings ($) | 5,974 |
| Construction cost[a] | 1,949 |
| Savings-to-investment ratio | 22.7 |
| Simple payback (years) | 0.33 |

[a]Construction cost breakdown:

| | |
|---|---|
| Material | 1,740 |
| Labor | 209 |
| Manhours (electrical) | 9.5 |

## Photosensors for Outside Lighting

Four surveyed buildings on Fort Ord and POM had outside floodlights operative 24 hours a day. If the operation of these lights were controlled by a photocell, turning them off during the daylight hours, substantial electrical energy could be saved.

| Economic analyses (per building) | |
|---|---|
| Annual energy savings (MBtu) | 50.8 |
| Annual energy savings ($) | 381 |
| Construction cost[a] | 127 |
| Savings-to-investment ratio | 22.2 |
| Simple payback (years) | 0.34 |

[a]Construction Cost Breakdown:
Material 39

## Boiler Tuneups

Boilers at Fort Ord and POM supply hot water or steam. These boilers are fired by individual burners that can be tuned to minimize excess air in the exhaust. This can be done on any of the boilers except those with inspiration gas burners.

Boiler tuning is a low-cost, low-investment project which can reap substantial energy savings.

| Economic analyses (per building) | |
|---|---|
| Annual energy savings (MBtu) | 184 |
| Annual energy savings ($) | 975 |
| Construction cost[a] | 93 |
| Savings-to-investment ratio | 9.7 |
| Simple payback (years) | 0.1 |

[a]Construction cost breakdown:

| | |
|---|---|
| Material | 13 |
| Labor | 80 |
| Manhours (mechanical) | 4 |

Timer for Circulating Hot Water Pump

The hot water systems in some buildings have circulating pumps. In most of these buildings the pumps operate full time. Shutting the pump off during times of no demand would save substantial energy and could be accomplished by adding a timer to the circuit.

| Economic analyses (per building) | |
|---|---|
| Annual energy savings (MBtu) | 73 |
| Annual energy savings ($) | 406 |
| Construction cost[a] | 399 |
| Savings-to-investment ratio | 8.57 |
| Simple payback (years) | 0.98 |

[a]Construction cost breakdown:

| | |
|---|---|
| Materials | 305 |
| Labor | 94 |
| Manhours (electrical) | 4.25 |

Insulate Ceilings

All of the wooden buildings on Fort Ord and POM have uninsulated walls and ceilings. In most cases, it would be prohibitively expensive to insulate the walls because of the additional construction which would be required. However, insulation of the ceilings is easy to accomplish and would save substantial energy.

Insulation of the ceilings can be accomplished by blowing 8-1/2-inches of fiberglass insulation into the attic to provide R-19 insulation.

Infrared Heater Replacement

Some of the buildings on Fort Ord and POM have gas fired space heating in open bays with isolated work stations. These space heaters waste a large amount of energy by heating the environment rather than the workers directly. Also, the air which has been heated can lose heat to cooler parts of the building where heat is not needed.

| Economic analyses (per building) | |
|---|---|
| Annual energy savings (MBtu) | 59.75 |
| Annual energy savings ($) | 317 |
| Construction costs[a] | 1,575 |
| Savings-to-investment ratio | 3.9 |
| Simple payback (years) | 5.0 |

[a]Construction cost breakdown:

| | |
|---|---|
| Material | 425 |
| Labor | 1,150 |
| Manhours (mechanical) | 55 |

Replacement of the space heaters with infrared heaters would save substantial energy. The infrared heaters would be placed directly over the work areas, heating only that area. Gas-fired or electric radiant heaters could be used.

| Economic analyses (per building) | |
|---|---|
| Annual energy savings (MBtu) | 140 |
| Annual energy savings ($) | 742 |
| Construction cost estimate[a] | 7,540 |
| Savings-to-investment ratio | 1.91 |
| Simple payback (years) | 10.2 |

[a]Construction cost breakdown:

| | |
|---|---|
| Materials | 3,540 |
| Labor | 4,000 |
| Manhours (mechanical) | 200 |

## Install High Efficiency Furnaces

Heating furnaces at Fort Ord and POM are generally older and hence not as efficient as the newer furnaces. Several of the surveyed buildings could benefit from replacing the existing furnaces with high efficiency furnaces. These high efficiency furnaces may not be direct replacements for the furnaces which are in the buildings now, however, the heating requirements can be met by combining different sizes of high efficiency furnaces.

Replacement of the existing older furnaces with high efficiency furnaces would save substantial gas fuel. Currently, high efficiency furnaces are available in 60,000, 80,000, and 100,000 Btu/hr sizes. For Fort Ord and POM, the necessary sizes can be supplied by combining furnaces of various sizes. Three economic analyses were completed. The analyses were done for:

- 2 -- 100,000 Btu/hr high efficiency furnace substituted for 1 -- 200,000 Btu/hr furnace
- 1 -- 80,000 Btu/hr high efficiency furnace substituted for 1 -- 80,000 Btu/hr furnace
- 1 -- 80,000 Btu/hr furnace and 1 to 60,000 Btu/hr furnace for 1 -- 150,000 Btu/hr furnace

Economic analysis (per building)

| | 1 | 2 | 3 |
|---|---|---|---|
| Annual energy savings (MBtu/yr) | 41 | 16.4 | 31 |
| Annual energy savings ($) | 217 | 87 | 164 |
| Construction cost[a] | 2,234 | 1,024 | 2,783 |
| Savings-to-investment ratio | 1.89 | 1.65 | 1.15 |
| Simple payback (years) | 10.2 | 11.8 | 16.9 |

| [a]Construction Cost Breakdown: | | | |
|---|---|---|---|
| Materials | 2,046 | 940 | 2,605 |
| Labor | 188 | 84 | 178 |
| Manhours (mechanical) | 9.4 | 4.2 | 8.9 |